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Abstract: We report a broadband supercontinuum generation in a chalcogenide fiber taper with an ultra-high numerical aperture. The chalcogenide step-index fiber consisting of As_2Se_3 core and As_2S_3 cladding was fabricated by using the isolated stacked extrusion method. The fiber taper with a core diameter of 1.75 μm was prepared by employing a homemade tapering setup. By pumping the fiber taper with a femtosecond laser pulses at 3.3 μm, a broadband supercontinuum generation spanning from 1.9 to 5.7 μm was achieved.

Keywords: Chalcogenide glass; fiber design and fabrication; fiber taper; nonlinear optics; Supercontinuum generation.

1. Introduction

Fiber-based supercontinuum (SC) sources spanning the mid-infrared (MIR) molecular fingerprint region are of great interest for revealing information about substance chemical structure [1]. They have important applications in many fields such as gas sensing [2], food quality control [3] and medical diagnostics [4]. Recently, extensive attention has been directed toward the development of SC sources with a special focus on extending the bandwidth of the SC spectrum, enhancing specific spectral components in the SC spectrum, and lowering the threshold of initiating the SC process. However, SC sources generated in silica glass fibers only span the visible and near-infrared region because of the material absorption at wavelength beyond 2 μm [5]. Several non-silica glasses have been proposed as candidates for MIR SC generation, including tellurite [6, 7], fluoride [8, 9] and chalcogenide (ChG) glasses [10-13]. The SC spectrum generated form tellurite or fluoride fibers extended to the wavelengths not longer than 5 μm, which were also limited by material absorption. Particularly, ChG fibers have advantages of wider transparency window (usually over 12 μm) [14] and higher optical nonlinearity (up to thousand times greater than that of silica glasses) [15], making them promising candidates to generate MIR SC.

Tapering is an important optical fiber post-processing technique that enables to dramatically increase the nonlinear parameters γ of the fibers, and engineer the total dispersion from normal to zero or even anomalous regions [16]. The first use of ChG tapered fiber was reported in 2007 [17]. In an As_2Se_3 tapered fiber with a waist diameter of 1.2 μm, E. C. Mägi et al. inferred an enhanced nonlinearity of 68 $W^{-1}m^{-1}$, which was 62000 times larger than that of standard silica single-mode fiber. In recent years, many experimental and theoretical investigations on MIR SC generation have been reported in ChG tapered fibers. Yeom et al. demonstrated an SC generation with a spectral bandwidth of more than 500 nm in a As_2Se_3 nanowire by pumping at 1550 nm with a low peak power of 7.8 W

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